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# Isotope News

For additional information, see our Web site at http://www.isotopes@ornl.gov, or contact R. L. Cline, clinerl@ornl.gov.

***Inside this issue***



I am pleased to welcome you to the reestablished Isotope Newsletter. This revived newsletter is designed for use as a forum to communicate the Department of Energy's isotope activities along with activities of the isotope community. Because of the global distribution of this newsletter, we encourage you to submit articles on your isotope activities, changes in the regulatory environment, upcoming events, or other newsworthy items regarding the production, use, or application of isotopes. Please feel free to offer suggestions and make contributions. Please submit comments or proposed news items to isotopes@ornl.gov.

John Pantaleo, Jr.

Initially the newsletter will be published twice per year. Eventually, we hope to publish quarterly. The newsletter will be sent electronically to customers and stakeholders maintained in our database. The newsletter will also be available on our website at http://www.ornl.gov/sci/isotopes/catalog.htm. If you are not currently receiving our newsletter and wish to do so, you can add your electronic mail address by following the instructions at this link: https://email.ornl.gov/mailman/listinfo/isotope-newsletter.

You may have learned of programmatic changes to the Isotope Program. Currently, the Office of Nuclear Energy, U.S. Department of Energy, is implementing a contractor-based isotope program. The overall goal is to better align the Department's isotope production mission with ever-changing national needs. The contractor-based isotope program will place the day-to-day management of isotope development, production, and distribution in the hands of those scientists at the National Laboratories who have frequent interactions with the isotope user community. The overall oversight and direction, to include program planning, pricing, budgeting, and performance assessment, will remain with the Program Director, DOE. The contractor-based isotope program supports two new positions in the program.

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Wolfgang Runde

Darrell Fisher

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Los Alamos National Laboratory scientist Wolfgang Runde will serve as the Isotope Program Manager, which includes coordinating and integrating DOE's isotope development, production, and facility needs. Pacific Northwest National Laboratory scientist Darrell Fisher will serve as the Scientific Director and will advise and develop advocacy for and participation in the Isotope Program**.** Isotope activities are conducted at five National Laboratories: Brookhaven National Laboratory, Idaho National Laboratory, Los Alamos National Laboratory, Oak Ridge National Laboratory, and Pacific Northwest National Laboratory.

I hope you will benefit from this Newsletter and again invite your participation.

John Pantaleo, Jr., Program Director
Isotope Program
Office of Nuclear Energy

# NRC Announces Appointment of New Member to the Advisory Committee on Medical Uses of Isotopes

On May 21, 2007, the Nuclear Regulatory Commission announced that Dr. Bruce Thomadsen will serve as the medical physicist in radiation therapy on the Advisory Committee on Medical Uses of Isotopes. For full text of the announcement, please go to the NRC web site at http://www.nrc.gov. The NRC offers a free list serve subscription at the following address: www.nrc.gov/public-involve/listserver.html.

# High-Yield Separation of Arsenic Isotopes

Chemistry staff member Dr. Michael Fassbender at LANL has developed a novel, convenient, hot-cell-tailored method for the high-yield separation of arsenic isotopes from proton-irradiated germanium targets. Using this proprietary method, a batch of 600 mCi highly pure arsenic-73 was prepared at LANL the week of March 19, 2007. Arsenic-73, with its half-life of roughly 80 days, is an important radioactive tracer for environmental and biomedical studies. Although arsenic radioisotopes were prepared at LANL in the past, these previous separation processes had always been associated with arsenic volatilities, long processing times, low product yields, and various product contaminants. The new method takes only a few days, requires few resources, is comparatively simple to implement, and avoids the use of highly toxic glass-etching hydrofluoric acid. Overall separation yields from target to shipping product solution are in the range of 85–90 percent.

# ORNL HFIR Restart

Oak Ridge National Laboratory's High Flux Isotope Reactor (HFIR) is back in action after $70 million and some 16 months in renovations. After restarting on May 6, HFIR reached its peak power of 85 megawatts on May 9. Built in 1966, HFIR is internationally known as a high-flux neutron source for materials studies and isotope production. The reactor returns with a suite of new instruments to conduct experiments, beam lines to channel neutrons, a new beryllium reflector, and other upgrades.

The restart marks HFIR's 408th cycle. (Each cycle represents 23–25 days and entails the complete burnup of its HEU core.) Current projections are for up to 10 reactor cycles per year with no major shutdown for a beryllium reflector replacement until after 2020.

In addition, three centrally located hydraulic tubes are also available for the rapid insertion and removal of Isotope Program targets that require short irradiation times. A wide variety of radioisotopes are currently made at the HFIR, including W-188, Ni-63, Cf-252, Se-75, and Fe-55. HFIR has historically produced a minimum of 100 additional radioisotopes.

Removal of fuel from the HFIR reactor core.

# $^{67}$Cu – Now Available

Trace Life Sciences, working in conjunction with DOE, is now manufacturing $^{67}$Cu on a regular basis. The first batches processed were warmly received by researchers wishing to advance their studies into the development of various radioimmunotherapies (RITs). To advance the progress of this research, Trace has obtained a Drug Master File #19791 for this isotope so that human trials can commence for a variety of potential RITs. Currently this isotope is available in batches ranging from 1 to 100 millicuries on a monthly basis or as customer needs dictate.

Plans are under way with DOE to have several sites in production, providing not only redundancy but also a significant increase in capacity. Currently $^{67}$Cu is produced on Trace's linear accelerator located in Denton, Texas; however, consideration is being given to expanding production on one of the cyclotrons.

Advances in chemistry have enabled this material to have higher specific activity and radionuclidic purity than previously available. By isolating all potential sources of "cold copper," this isotope has incorporated better "than any $^{67}$Cu ever available," notes one leading researcher.

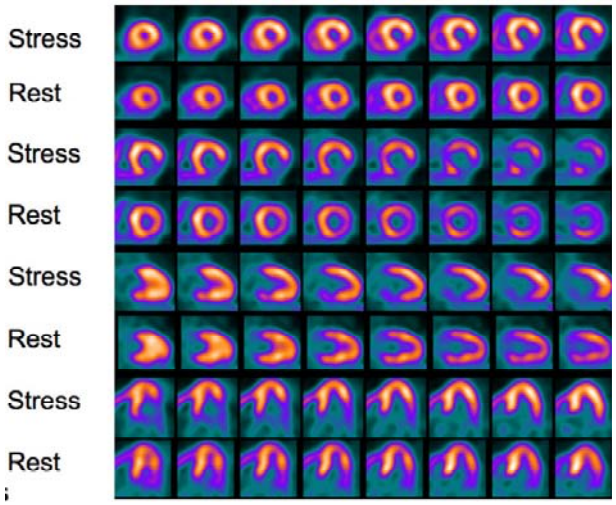
Trace Life Sciences also offers $^{111}$In, $^{123}$I, $^{64}$Cu, and $^{201}$Tl—all under Drug Master files.

Trace Life Sciences Linac in Denton, Texas.

# DOE Accelerators Finish Unprecedented Production Cycles for Strontium-82 Product

The two DOE accelerator sites, Los Alamos National Laboratory (LANL) and Brookhaven National Laboratory (BNL), have just finished unprecedented production cycles in which the accelerator facilities were operated in a dedicated mode. These dedicated production runs allowed the Isotope Program to generate approximately 13 curies of Sr-82 at LANL and 4.5 curies of Sr-82 at BNL (end of beam). The irradiated targets are chemically processed by well-trained staff, and the purified FDA-approved Sr-82 product is sent to GE Healthcare for CardioGen generator loading and subsequent distribution to hospitals. The daughter of Sr-82, rubidium-82, is used for cardiac imaging via positron emission tomography (PET) at hospitals nationwide. Each generator is used for 5–6 weeks of patient doses, impacting 10,000–14,000 patients. Nearly 400 cardiac patients are diagnosed each day.

The normal Brookhaven Linear Accelerator Isotope Producer (BLIP) operating mode shares the use of the BNL linear accelerator (Linac) with major programs in nuclear physics that utilize polarized protons. The sole dedicated use of the Linac by BLIP was necessary because the schedule of nuclear physics operations would not have allowed continuity of Sr-82 supply. The Collider Accelerator Department at BNL manages the Linac operation.




PET images from an abnormal rest-stress CardioGen-82® myocardial perfusion PET study. PET images like this help diagnose cardiac conditions.


CardioGen-82® (Rb-82 generator).

The irradiated targets were processed by the staff of the Target Processing Lab (TPL) of the Medical Department. The Radionuclide Production Group at BNL is responsible for BLIP and TPL maintenance and operation and has eight staff members.

At LANL, when the Los Alamos Neutron Science Center (LANSCE) accelerator runs are solely dedicated to the production of isotopes, only the front end of the accelerator is operated to provide protons up to 100 MeV. The remainder of the facility is without beam and therefore can undergo routine maintenance and upgrade. The Sr-82 was processed at the hot cell facility at TA-48-RC-1 by a team of eight radiochemists in the Inorganic Isotope and Actinide Chemistry Group. The LANL Isotope Production team responsible for the work consists of about 18 people, including the Isotope Production Facility at LANSCE and the processing team at TA-48.

This work is supported by DOE NE-32.

# e ORNL Nuclear Medicine Program Develops Efficient Method for Separation of Promethium-147 from Reactor-Produced Neodymium-147

F. F. (Russ) Knapp, Saed Mirzadeh, and Rose Boll, Oak Ridge National Laboratory

Promethium-147 (half-life = 2.62 years) decays with the emission of very low energy electrons (beta $E_{av}$ = 61.96 keV, 99.99%) and is of wide interest for use in many special devices, including fluorescent instruments and low-power beta batteries. Because the uranium fission yield is about 2.25%, high activity levels of promethium-147 have traditionally been obtained from the processing of uranium fission products. The DOE Isotope Program and predecessor organizations (AEC/ERDA) had distributed promethium-147 from ORNL for a number of years until the early 1980s. The promethium-147 was obtained from processing of uranium fission products at PNNL. In fact, an inventory as high as 20,000 curies had been available for distribution through the ORNL Isotope Distribution Office.

Because the required large-scale fission product processing capabilities are no longer available in the United States, the promethium-147 needed for important Homeland Security and industrial applications is available solely through importation from foreign sources. Because very high levels of radioactive waste are formed during fission product processing and because of the broad interest in the availability of promethium-147, the ORNL Nuclear Medicine Program has assessed the reactor production of neodymium-147 from enriched neodymium-146 (Figure 1) in the High Flux Isotope Reactor (HFIR) and demonstrated the efficient separation of promethium from neodymium. This work was supported through internal ORNL exploratory funding provided by the Nuclear Science and Technology Division, and a U.S. Patent is

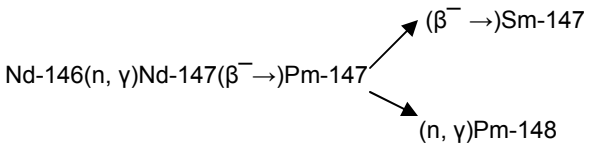



**Figure 1.** Summary of the key species for the production and decay of promethium-147 from enriched neodymium-146.

Based on published neutron cross-section values, the projected production of neodymium-147 via irradiation of enriched neodymium-146 targets in the Peripheral Target Positions (PTPs) of the ORNL HFIR, shown in Figure 2, illustrates that neodymium-147 yields of approximately 1Ci/g of enriched neodymium-146 are expected to be produced during an approximate 24-day-cycle HFIR irradiation. These estimates were based on irradiation in the HFIR (PTPs) (i.e., peak axial thermal neutron flux = 1.3 x $10^{15}$ neutrons·cm$^{-2}$·s$^{-1}$ because of the large target volume available in these positions.

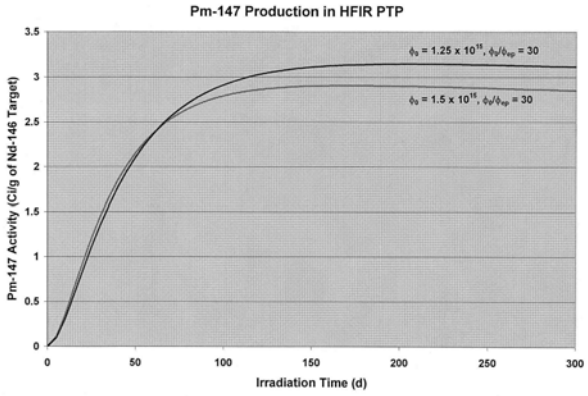



**Figure 2**. Calculated HFIR production of neodymium-147 from enriched neodymium-146 in the PTPs of the HFIR (courtesy of Marc Garland, Ph.D.).

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Because of the projected modest production yields and the high amounts of enriched neodymium-146 target material that will be required for the production of high multicurie levels of promethium-147, large-target-volume reactor positions are required for the production of high multicurie levels. In addition to the HFIR PTPs, the target positions in the HFIR flux-trap region (Fig. 3) where curium-244 targets are irradiated for production of californium-252 have the highest thermal neutron flux (2–2.5 x $10^{15}$ neutrons·cm$^{-2}$·s$^{-1}$) and could also be used for neodymium-147 production to increase the promethium-147 production yields.

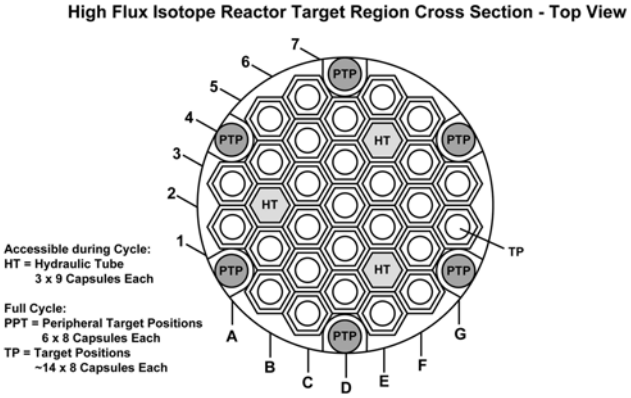


**Figure 3.** Cross section of the HFIR flux-trap target regions.

The approach was to evaluate the HEDHP-based lanthanide extraction column separation of promethium from neodymium, which we had successfully used previously for the separation of no-carrier-added lutetium-177 from ytterbium-177, produced by HFIR irradiation of enriched ytterbium-176. The detection of neodymium-147 and promethium in the column fractions was assessed by gamma spectroscopy. Although the detection and quantification of promethium-147 by gamma spectroscopy is difficult because of the emission of only X-rays and very low abundance gamma photons, the separation of promethium from neodymium can be conveniently monitored by analysis of the gamma photon emissions from the promethium-148 (half-life = 41.3 days) surrogate—for example, the 550-keV-γ photon emitted with an abundance of 22%. The promethium-148 is formed during neutron irradiation by subsequent neutron capture by the promethium-147 decay product (Figure 1).

We have evaluated several different column adsorbent configurations and acid concentrations and have optimized this approach at the tracer level to demonstrate for the first time the excellent separation of promethium from neodymium using this technique and HFIR-produced neodymium-147, as illustrated in Figure 4. The promethium-147 product and neodymium are also effectively separated from iridum-192 and other radionuclide contaminants produced during the irradiation process.

Scale-up of this process to provide multicurie levels of promethium-147, and development and optimization of methods to recover the enriched neodymium-146 target material for subsequent irradiations are required to demonstrate the expected practicality of this approach to routinely provide promethium-147.

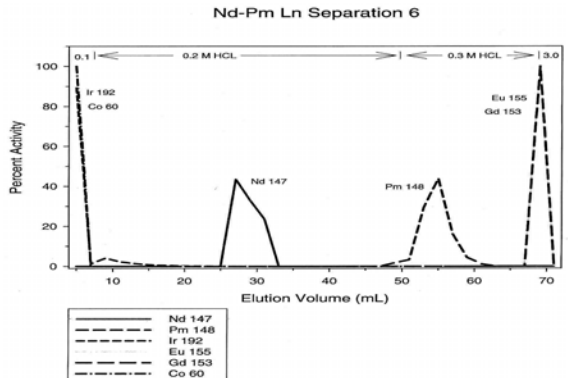


**Figure 4.** Illustration of the effective separation of promethium from neodymium.

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Although the levels of promethium-147 production by processing of fission products are much higher, this "indirect" reactor production route is expected to be a useful alternative to produce small quantities of this important radioisotope. Now that ORNL has developed this technology, it is expected to be useful for HFIR production of sufficient neodymium-147, which will provide promethium-147 in R&D batch quantities of 500–1000 curies.

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